

Claims

- [c1] 1.A method of testing electromagnetic connectivity in transmission path in a drill string, comprising:
transmitting a test signal down the transmission path;
receiving a reflection of the test signal; and
determining from the reflection whether there is an interruption in the electromagnetic connectivity in the transmission path.
- [c2] 2.The method of claim 1, wherein transmitting the test signal includes transmitting a sine wave signal.
- [c3] 3.The method of claim 1, wherein transmitting the test signal includes transmitting the test signal from a test apparatus electromagnetically coupled to the transmission path.
- [c4] 4.The method of claim 1, wherein transmitting the test signal includes transmitting the test signal across an electromagnetically coupled joint.
- [c5] 5.The method of claim 1, wherein transmitting the test signal includes transmitting the test signal across a plurality of electromagnetically coupled joints.

- [c6] 6.The method of claim 1, wherein receiving the reflection includes receiving a reflection indicating one of a good connection in the drill string and a bad connection in the drill string.
- [c7] 7.The method of claim 6, wherein receiving the reflection indicating a bad connection includes receiving a signal indicating one of a shorted box end, an open box end, a shorted pin end, and an open pen end.
- [c8] 8.The method of claim 1, wherein determining from the reflection whether there is an interruption in the electro-magnetic connectivity in the transmission path includes determining whether the interruption occurs from a shorted box end, an open box end, a shorted pin end, and an open pen end.
- [c9] 9.The method of claim 1, determining from the reflection whether there is an interruption in the electromagnetic connectivity includes comparing the reflection to a reference.
- [c10] 10.The method of claim 9, wherein comparing the reflection to a reference includes one of visually comparing the reflection to a reference and electronically comparing the reflection to a reference.
- [c11] 11.The method of claim 1, further comprising generating

the test signal.

- [c12] 12.The method of claim 1, further comprising displaying the reflection before the determination.
- [c13] 13.The method of claim 1, further comprising indicating whether there is an interruption in the electromagnetic connectivity in the transmission path.
- [c14] 14.An apparatus for testing electromagnetic connectivity in a transmission path in a drill string, comprising:
a signal generator that generates a test signal into the transmission path in the drill string;
a receiver for a reflection of the test signal; and
means for determining from the reflection whether there is an interruption in the electromagnetic connectivity in the transmission path.
- [c15] 15.The apparatus of claim 14, wherein the generator generates a sine waveform.
- [c16] 16.The apparatus of claim 14, wherein the generator comprises one of a crystal-based oscillator and a network analyzer.
- [c17] 17.The apparatus of claim 14, wherein at least one of the generator and the receiver includes a coil.
- [c18] 18.The apparatus of claim 14, wherein the generator and

the receiver share a single coil.

- [c19] 19.The apparatus of claim 14, wherein the determining means includes a signal processor that compares the reflection to a reference.
- [c20] 20.The apparatus of claim 14, wherein the signal processor comprises one of an electronic amplifier and a programmed computing apparatus.
- [c21] 21.The apparatus of claim 14, further comprising means for indicating whether there is an interruption in the electromagnetic connectivity in the transmission path.
- [c22] 22.An apparatus for testing electromagnetic connectivity in a transmission path in a drill string, comprising:
 - a signal generator;
 - a coil through which a test signal generated by the signal generator may be transmitted into a drill string and through which a reflection of the test signal may be received; and
 - means for determining from the reflection whether there is an interruption in the electromagnetic connectivity in the transmission path.
- [c23] 23.The apparatus of claim 22, wherein the signal generator comprises one of a crystal-based oscillator and a network analyzer.

[c24] 24.The apparatus of claim 22, wherein the determining means includes a signal processor that compares the reflection to a reference.

[c25] 25.The apparatus of claim 22, wherein the signal processor comprises one of an electronic amplifier and a programmed computing apparatus.

[c26] 26.The apparatus of claim 22, further comprising an indicator capable of indicating whether there is an interruption in the electromagnetic connectivity in the transmission path.

[c27] 27.The apparatus of claim 22, wherein the indicator is capable of at least one of visually and aurally indicating whether there is an interruption in the electromagnetic connectivity in the transmission path.

[c28] 28.An apparatus, comprising:
a drill string;
a transmission path through the drill string;
a testing apparatus electromagnetically coupled to the transmission path and capable of:
transmitting a test signal down at least a portion of the transmission path;
receiving a reflection of the test signal; and
determining from the reflection whether there is an in-

interruption in the electromagnetic connectivity in the transmission path.

[c29] 29. The apparatus of claim 28, wherein the drill string includes at least one of a section of drill pipe, a tool, and a bit.

[c30] 30. The apparatus of claim 28, wherein the transmission path includes:

a first pair of electromagnetic couplers;

a first conductor electrically connecting the first pair of electromagnetic couplers;

a second conductor; and

a second pair of electromagnetic couplers connected by the second conductor, one of the second pair of electromagnetic couplers being electromagnetically coupled to one of the first pair of electromagnetic couplers.

[c31] 31. The apparatus of claim 28, wherein the testing apparatus comprises a dedicated section of the drill string.

[c32] 32. The apparatus of claim 28, wherein the testing apparatus is hosted on a non-dedicated section of pipe.

[c33] 33. The apparatus of claim 28, wherein the testing apparatus comprises:

for a signal generator that generates a test signal into the drill string;

a receiver that receives a reflection of the test signal; and means for determining from the reflection whether there is an interruption in the electromagnetic connectivity in the transmission path.

[c34] 34.The apparatus of claim 28, wherein the testing apparatus comprises:
a signal generator;
a coil through which a test signal generated by the signal generator may be transmitted into a drill string and through which a reflection of the test signal may be received; and
means for determining from the reflection whether there is an interruption in the electromagnetic connectivity in the transmission path.

[c35] 35.The apparatus of claim 28, further comprising a downhole local area network over which the testing apparatus can transmit the data representing the reflection to the test signal .

[c36] 36.An apparatus for testing electromagnetic connectivity in transmission path in a drill string, comprising:
a drill string;
a transmission path through the drill string;
at least one testing apparatus capable of:
transmitting a test signal down at least a portion of the

transmission path; and
receiving a reflection of the test signal; and
transmitting data representing the reflection;
a downhole local area network over which the testing
apparatus can transmit the data representing the reflection to the surface; and
a computing apparatus programmed to receive the
transmitted data and facilitate determining from the reflection whether there is an interruption in the electromagnetic connectivity in the transmission path.

[c37] 37.The apparatus of claim 36, wherein the drill string includes at least one of a section of drill pipe, a tool, and a bit.

[c38] 38.The apparatus of claim 36, wherein the transmission path includes:
a first pair of electromagnetic couplers;
a first conductor electrically connecting the first pair of electromagnetic couplers;
a second conductor; and
a second pair of electromagnetic couplers connected by the second conductor, one of the second pair of electromagnetic couplers being electromagnetically coupled to one of the first pair of electromagnetic couplers.

[c39] 39.The apparatus of claim 36, wherein the testing appa-

ratus comprises a dedicated section of the drill string.

[c40] 40. The apparatus of claim 36, wherein the testing apparatus is hosted on a non-dedicated section of pipe.

[c41] 41. The apparatus of claim 36, wherein the testing apparatus comprises:

means for generating a test signal;

means for transmitting the test signal into a drill string;

means for receiving a reflection of the test signal may be received; and

means for determining from the reflection whether there is an interruption in the electromagnetic connectivity in the transmission path.

[c42] 42. The apparatus of claim 36, wherein the testing apparatus comprises:

a signal generator;

a coil through which a test signal generated by the signal generator may be transmitted into a drill string and

through which a reflection of the test signal may be received; and

means for determining from the reflection whether there is an interruption in the electromagnetic connectivity in the transmission path.